Practice Exercises for BIO 1011/1015 Cells Lab

Dilution of Stock Solutions

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please note: numbers in scientific notation are written below using the abbeviation e for exponent of ten. For example: 2e3 for 2 x 1000 and 1.5e-2 for 1.5 x 0.01 or 0.015

u will be used for the symbol for micro below

mL and ml are used interchangably for milliliters

What is the dilution factor for a dilution in which a 20 mM sucrose solution was made from a 0.2 M stock solution?

$$0.2\ M \times \frac{(1000\ mM)}{1\ M} = 200\ mM$$

So the dilution factor is $\frac{20\ mM}{200\ mM} = \frac{1}{10} = 1e\text{-}1$

This is a ten-fold dilution. You would take 1 ml of stock and dilute to 10 ml. You would add (10 minus1) ml = 9 ml of water.

What if you wanted 0.5 L in the end? find one tenth this volume for the amount of stock to start with, then convert to convenient units:

$$0.5\ L \times \frac{1}{10} = 0.05\ L \times \frac{1000\ mL}{1\ L} = 50\ mL$$

or convert the 0.5 L to 500 ml right away and take 1/10 of this: 50 ml plus water to 500 ml, that would entail adding 450 ml. If you had a 500 ml volumetric flask, you could put the 50 ml of the 0.2 M sucrose into this & fill to the line.

What if you had only 10 ml of the 0.2 M stock solution and wanted to use this 10 ml to make up the 20 mM working solution. How much could you make?

Well, for each 1 ml you could make 10 ml. So for 10 ml you can make up 10 x 10 ml = 100 ml.

What if you had only 1.5 ml of the stock solution?

You could make 1.5 ml x 10 = 15 ml of the 0.2 M working solution (dilution).

Remember to check that you have MORE volume in your final dilution than the volume of STOCK solution you started with for your dilution.

What about this: You have a 1 M stock solution of glucose and you want to prepare three separate dilutions:

A. 100 mM glucose
B. 10 mM glucose
C. 0.1 mM glucose

Well, to start with, convert the stock solution concentration to mM for comparison:
1 M = 1000 mM

- **A. To make a 100 mM glucose**, this is a 1/10 dilution:

  100 mM/1000 mM = 1/10

  you could dilute 1 ml to 10 ml final volume (1 ml of the 1 M stock solution plus 9 ml water) or, if you wanted more, 10 ml to 100 ml final volume or 100 ml to 1 L final volume. How'd I get that last one?

  1 L = 1000 ml and 1000 ml x 1/10 = 100 ml
  so 100 ml diluted with 900 ml of water would give that 10x dilution (this is similar to the 100 ul + 900 ul dilution of the blue dye you did in lab).

- **B. To make a 10 mM glucose from the 1 M (=1000 mM) glucose stock solution:**

10 mM/1000 mM = 1/100 So, this is a 100-fold dilution or a 1e-2 ("ten to the minus two") dilution. You could take 1 ml of the 1 M glucose and add 99 ml of water to get 100 ml total solution.

What if you wanted to make up 25 ml of the 10 mM?
1/100 x 25 ml = 0.25 ml So start with 0.25 ml.

How would you use the pipetman to do this? They measure in microliters.

```
0.25 ml x 1000 ul     250 ul   The P1000 would read:   0
          ------- =            (use blue tip)          2
            1 ml                                       5
```

You could then take this 250 ul & put it into a 25 ml volumetric flask & dilute to the line... Now, note that this may be getting a little tricky to do it all in your head. So, WRITE IT DOWN. When you make up solutions, especially for an experiment, you should write down what you did & your calculations so you can check it over & refer to it later.
Let's check this:

```
250 ul/25 ml should be equal to 1/100:

     conversion     units cancel     0's & 25's cancel

250 ul    1 ml      250      1       25     1     1
-----  x  -----  =  ----- x -----  = --  x ---  = ---
25 ml     1000 ul   25       1000    25    100    100
```

- **C. To make 0.1 mM from a 1 M (=1000 mM) stock**
  Now this is getting to be too large a dilution to do in one step. It is:

```
0.1 mM      1
------ = -------= 1e-4
1000 mM  10,000
```

That's a "ten to the minus 4" dilution. It would be more accurate to do it in two steps of 1/100 each (1/100 x 1/100 = 1/10,000).

The first step would be to make a 1/100 x 1000 mM = 10 mM solution. We did that in part B. So, now use some of this 10 mM glucose to make up the 0.1 mM glucose using a 1/100 dilution.

  - You could take 1 ml and dilute to 100 ml with water.
  - You could take 0.1 ml and dilute to 10 ml with water. How much water do you add?
  - You could take 0.01 ml (10 ul) and dilute to 1 ml (1000 ul) by adding 990 ul of water & mixing in an eppendorf tube.
  - You could take 250 ul of the 10 mM glucose and dilute it in a clean 25 ml volumetric to make 25 ml of the 0.1 mM glucose (similar to the way you made the 10 mM from the 1 M original stock solution). Can you see why?
  - For any desired final volume start with 1/100 that volume of the 10 mM solution to make the 0.1 mM soluton.
  - For any volume of 10 mM you start with, make up 100 x that in final volume for a 1/100 dilution to get to 0.1 mM.
  - Imagine you have a reaction mixture for determining enzyme activity & your final volume is 3 ml. You want to have 0.1 mM glucose in each final reaction mixture and you have made your 10 mM glucose stock (which is 100x the desired concentration of 0.1 mM). How much do you add to each mixture?

```
dilution       convert to ul by multiplying 3 x 1000

3 ml  x  1    = 3000 ul  x 1    = 30 ul
         ---               ---
         100               100
```

What about % (w/v) solutions?

These are given in g of solute *per* 100 ml of total solution and so can be diluted and used as stock solutions.

- Make 1 L of a 2%(w/v) NaCl from a 20%(w/v) stock solution.

```
2%       1                  1
---  =   --    so you need  -- x 1 L = 0.1 L = 100 ml
20 %     10                 10
```

measure out 100 ml of 20% stock and add water to 1 L to get the 2% solution. It works the same way as the other 1/10 dilutions.

- Make a 1% (w/v) KCl solution from a 50%(w/v) stock solution, making a total of 100 ml.

```
1%       1                  1
---  =   --    so you need  -- x  100 ml = 2 ml
50 %     50                 50
```

So, measure out 2 ml of the 50% KCl and dilute it to 100 ml with water & mix. This was a 1/50 dilution. 1/2, 1/5, 1/20, 1/50 dilutions are almost as easy as 1/10 & 1/100 are.

 **Now try these without looking at the examples:**

1. How would you make up 100 ml of a 40 mM glucose solution from a 400 mM stock solution?
2. How would you make up 100 ml of a 4 mM glucose solution from a 400 mM stock solution?
3. How would you make up 100 ml of a 15 mM glucose solution from a 1.5 M stock solution?
4. How would you make up 30 ml of a 45 mM glucose solution from a 90 mM stock solution? (so, this isn't a 10 or 100 fold dilution, but use the same logic)
5. Starting with 5 ml of a 50 mM stock solution make up a 5 mM solution
6. Starting with 0.1 ml of a 0.5 M stock solution make up a 50 mM solution.
7. Starting with 10 ml of a 50 mM stock solution make up a 10 mM solution (so, this isn't a 10 or 100 fold dilution, but use the same logic)
8. Use serial dilution to make a 0.2 mM solution from a 2 M stock solution.
9. Use serial dilution to make a 2 mM solution from a 2 M stock solution.
10. You are given a 1 M NaCl solution and need a 10 mM NaCl solution for your experiment. You need 5 ml for each run and are doing 6 runs, so you figure you need 5 ml x 6 = 30 ml and decide to make up an even 50 ml so you have extra. How much 1 M NaCl do you measure out into your 50 ml volumetric flask?

To visit other pages

- Practice Problem Main Menu
- Cells Course Home Page
- Biology Home Page

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